scientific monitoring inc
Monitoring for Asset Optimization

Monitoring Essentials for CBM Applications

Starting in the early 1980's, the first digital engine control was implemented on the Pratt & Whitney F100 engine which is flown on the F-15 and F-16. This was the dawn of computers being connected to aircraft engines and systems, and the use of software and computers for the science of Condition Based Maintenance (CBM) for aviation was off and running. Despite this long history, there are still many people who are mystified by the technology. There are fundamentally five steps to CBM systems as shown in Figure 1. They are data analysis, state detection, health assessment, prognostics, life prediction and recommendations. These steps are consistent with MIMOSA's Enterprise Application Integration (EAI) framework, OSA-CBM's data model and ISO's CBM model, and SMI's software is compliant with these standards. Much discussion in condition monitoring focuses only on the data analysis and anomaly detection, when it is equally important to understand health assessment and prognostics, as they determine how quickly maintenance intervention is needed, and how aggressively to take action. Some equipment degrades slowly, and can spend a significant part of its usable life in the life extension phase before faults become noticeable and require intervention.

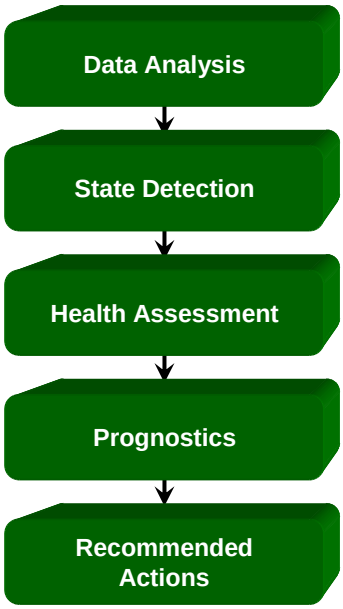

Figure 1. Five Step CBM Model

SMI has introduced a suite of tools called Intelligent Condition based Equipment Monitoring Software/services, or ICEMS™ to manage all five phases of CBM. ICEMS has six modules in the suite which are depicted in Figure 2. The modules align with the five-step CBM architecture, providing tools that support the CBM analysis workflow in an integrated tool set. SMI also provides a life extension module, which assists in setting realistic maintenance and repair timelines or intervals.

Not all equipment or systems under condition monitoring require the full functionality of ICEMS. For these customers, SMI has a version of ICEMS that provides condition monitoring functionality where the decision support and life extension issues are simpler to manage. This version is called I-Trend™.

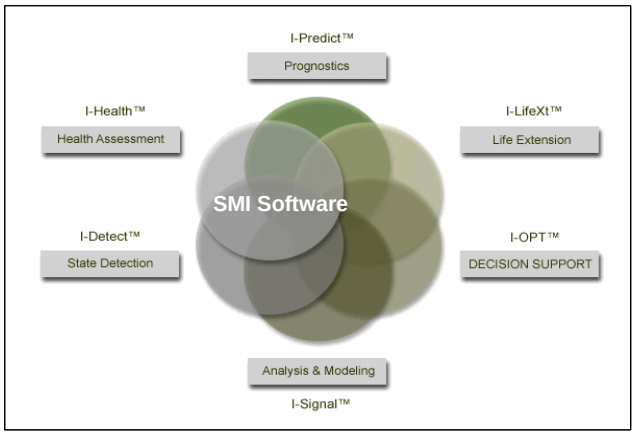

Figure 2. ICEMS Software Modules

With most processes, the first few steps are crucial, and condition monitoring is no exception. SMI uses a sophisticated intelligent system to provide the most accurate condition monitoring analysis and anomaly detection results possible. Both ICEMS and I-Trend use this technology, as illustrated in Figure 3. In addition to classical data analysis techniques (Kalman filters, control charts and regression analysis to name a few), physical models of the system are combined with an artificial intelligence learning system to produce an analysis tool that greatly reduces the variance in the data from a system. This approach provides a tool that can provide a high degree of fidelity, and therefore a high degree of alert accuracy.

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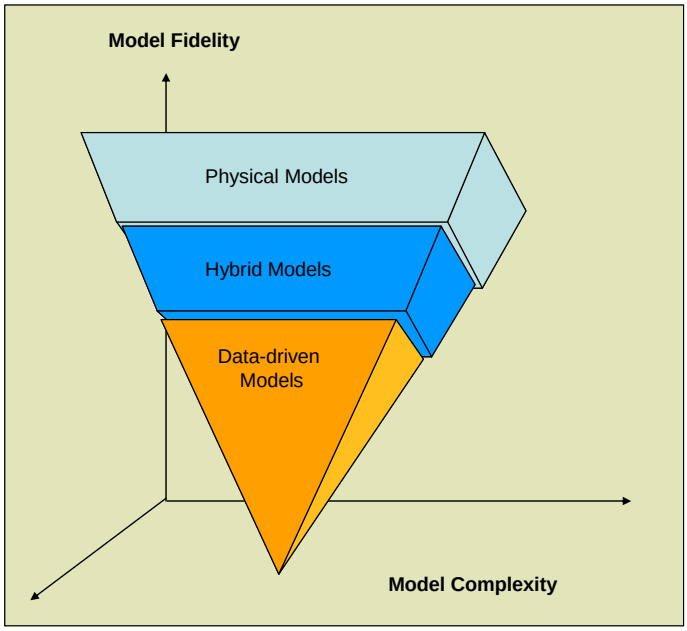

Figure 3. Scalable Model Complexity for High Fidelity Equipment Models

A simple way to think about the condition monitoring approach to controlling a physical system is to imagine starting your car on a cold day. The oil is cold and viscous, and it would be no surprise that the oil pressure would be quite high until the oil warms up. But if you were just looking at oil pressure, that cold-start data point might look like a problem. And if you regularly start your car at cold temperature, the alert level you would have to set based on pressure alone would be quite high. Generally too high to catch a real problem until it has become an urgent problem. A model-based system with learning capabilities can include other relevant parameters like temperature or engine speed to significantly tighten the variance in the data. The result is that a real problem is much more detectable, and the anomaly stands out clearly.

In fact, the indications of an impending problem frequently show up long before maintenance action is needed. This allows scheduling and planning of parts, people, and facilities in an orderly fashion, and the operational impact to an expensive asset like an airplane can be minimized. The five-step process of CBM moves the maintenance function from a reactive role to a proactive role with huge operational benefits.

Condition monitoring technology is rapidly moving into the mainstream. SMI's commercial successes are generally kept proprietary, but SMI can point to public information with the US Air Force, where a demonstration test program with a portion of the F-16 fighter jet fleet resulted in significant operational benefits for the maintenance wing. Throughout the test program, data was collecting with normal procedures, and with SMI's ICEMS™ condition monitoring software. Of the 640 alerts collected from the aircraft systems, ICEMS validated that nearly half (47%) of the alerts were false alarms which would have resulted in a no-fault-found (NFF) maintenance action. The ICEMS software reduced the workload for the maintenance team to only 60 actionable maintenance issues. (Not all alerts are maintenance related.) In addition, the need for maintenance was clearly visible much earlier, leading to fewer crisis repair actions. This not only reduces the workload for the maintenance team, but it increases the availability of the aircraft, as it's not in the shop for a maintenance action that will result in a no fault found diagnosis. The aircraft is out flying as planned with no disruptions. As a result of the success of this program, SMI is now under contract to embed the ICEMS software in the Air Forces' new health monitoring program. The potential benefits have also been noticed by the RAF, who are also evaluating elements of SMI's software to embed in their next generation maintenance analysis tools for their fighter aircraft fleet.

ICEMS and I-Trend Features

- Open architecture easily interfaces to existing systems
- Portable J2EE software environment
- Scalable
- Easy to use web-based thin client

Capabilities:

- Asset performance trending
- Customizable notification & alert generation
- Simple to use configuration and administration tools
- Fault detection and isolation module
- Auto baseline and auto segment data

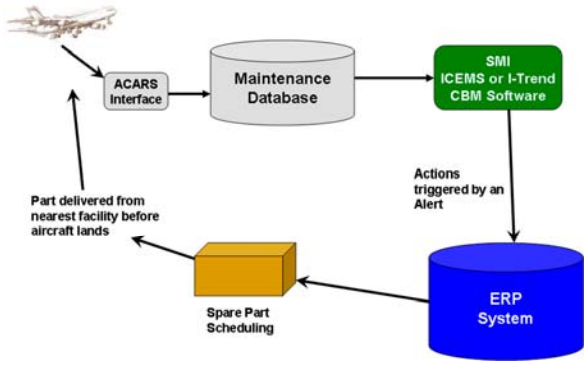

Figure 4. Enterprise Software Architecture

The benefits of condition monitoring are compelling, but the most exciting changes in condition monitoring have been the recent software architectural changes that allow the implementation of component-based architectures like J2EE and open standard interfaces like XML. This has allowed SMI's software suite to be readily connected to legacy systems, such as maintenance data interfaces, and enterprise resource planning systems (ERP), as shown in Figure 4. "These changes have made it much easier to connect with existing enterprise systems," commented Dr. Link Jaw, president and CEO of SMI. "We see a whole new set of logistical and scheduling benefits for customers, as the ICEMS software immediately alerts the operator's ERP system, which schedules delivery of spare part inventory and maintenance facilities for a plane that may still be in the air. It's a huge step up in the value of CBM software." So far, SMI's successes have been in ground based application of the CBM technology, but the advances in software interfaces make it possible to insert into onboard applications as well.

Intelligent condition monitoring systems like ICEMS and I-Trend are poised to solve many of the aviation world's complex maintenance problems. As more and more on-board equipment becomes computer-based, the amount of data becomes overwhelming, and the warning signals can get lost in the noise. Condition monitoring software provides a way to filter through massive amounts of data to create the significant few pieces of information that allow the accurate assessment of the health of complex, expensive equipment. Because these tools include a learning algorithm in them, the analytical tool evolves as the equipment evolves to insure that the organization hasn't replaced maintenance staff with software engineers and IT staff.

Let SMI's leadership CBM products help you manage your complex assets in the new millennium.

For more information, please call 480-752-7909 or email us at sales@scientificmonitoring.com